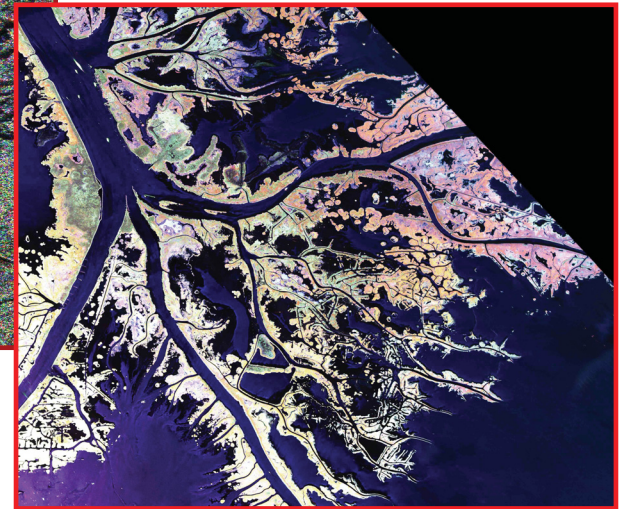
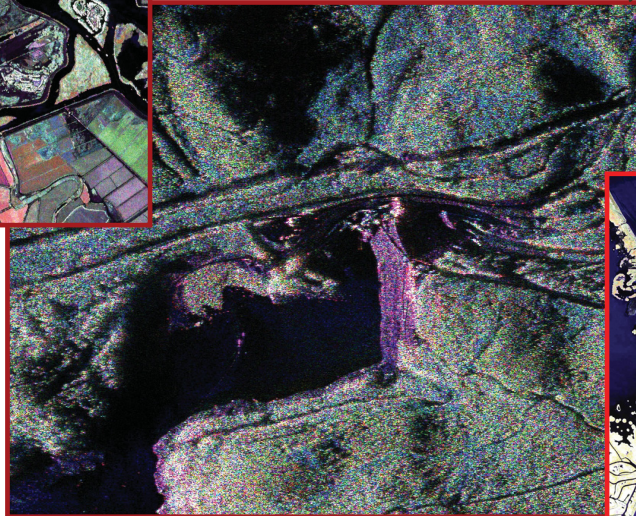


Synthetic Aperture Radar Monitoring Capabilities:



Levees ...,

Dams ...,



Cathleen E. Jones

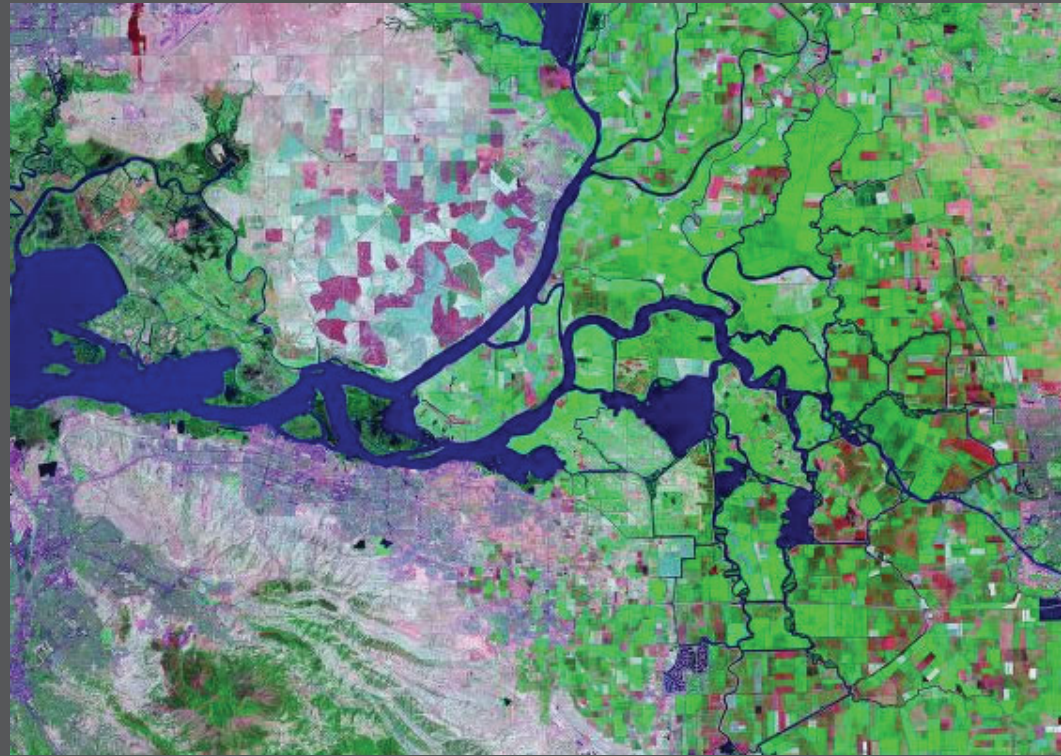
Jet Propulsion Laboratory, California Institute of Technology

June 9, 2011

...and the Gulf Oil Spill

Radar Measurements of the Sacramento-San Joaquin Delta

Critical Infrastructure: The Levees



- Over 60 reclaimed islands surrounded by 1100 miles of levees
- Most islands lie below mean sea level.
- Collects run-off from approximately 2/3 of the state via the Sacramento and San Joaquin rivers.
- Supplies water to ~2/3 of the residents of California and to almost all of the agriculture of the Central Valley.

THE DELTA IS THE MOST CRITICAL WATER RESOURCE IN CALIFORNIA.

Radar Measurements of the Sacramento-San Joaquin Delta

NASA Applied Science: The Project

Project: Monitoring Levees and Subsidence in the Sacramento-San Joaquin Delta

Funding Agency: NASA

Decision Support Partner: Ca. Dept. of Water Resources

Duration: 2010-2012

Objectives:

Provide an *independent and verifiable* source of information with the *spatial extent* needed to cover the 1100 miles of levees within the Delta, with sufficient *ground resolution* and *temporal frequency* to detect changes indicative of potential levee failure.

Risk Assessment & Disaster Management (Levees)

- Assess changes in levees on a monthly basis.
- Support emergency response to floods.

Water Resource Management (Subsidence/Levees)

- ***Short Term:*** Support decisions on the allocation of funds for levee repairs.
- ***Long Term:*** Provide critical subsidence rate measurements to inform a viable long term water management plan.

Radar Measurements of the Sacramento-San Joaquin Delta

Focus on Decision Support: The Partners



- Remote Sensing Radar Instrument
- Radar Processing Expertise



Decision Support Partner for improved flood protection

- Levee integrity
- Levee repair
- Flood emergency response



- Hydrology
- Earthquake & Fault Analysis



- Hydrology / Subsidence
- Long-term modeling of Delta

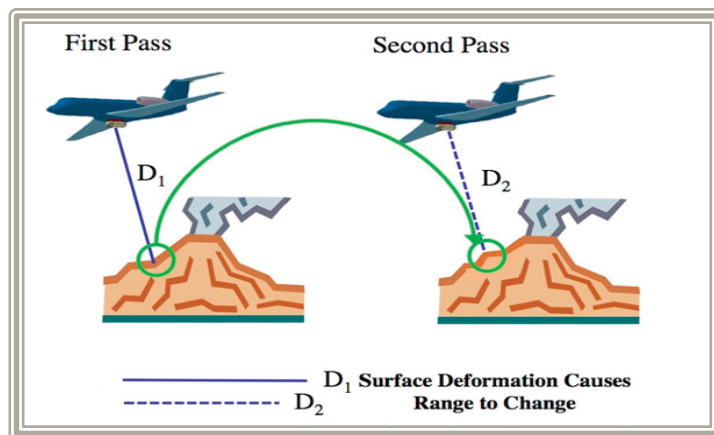
Jet Propulsion Laboratory (Dr. Cathleen Jones (P.I.), Dr. Scott Hensley)
California Dept. of Water Resources, Delta-Suisun Marsh Office (Mr. Joel Dudas)
USGS, Ca. Water Science Center & Southern California Earthquake Center (Dr. Gerald Bawden)
HydroFocus, Inc., Davis, Ca. (Dr. Steven Deverel)

Radar Measurements of the Sacramento-San Joaquin Delta

The Instrument: UAVSAR (Uninhabited Aerial Vehicle Synthetic Aperture Radar)

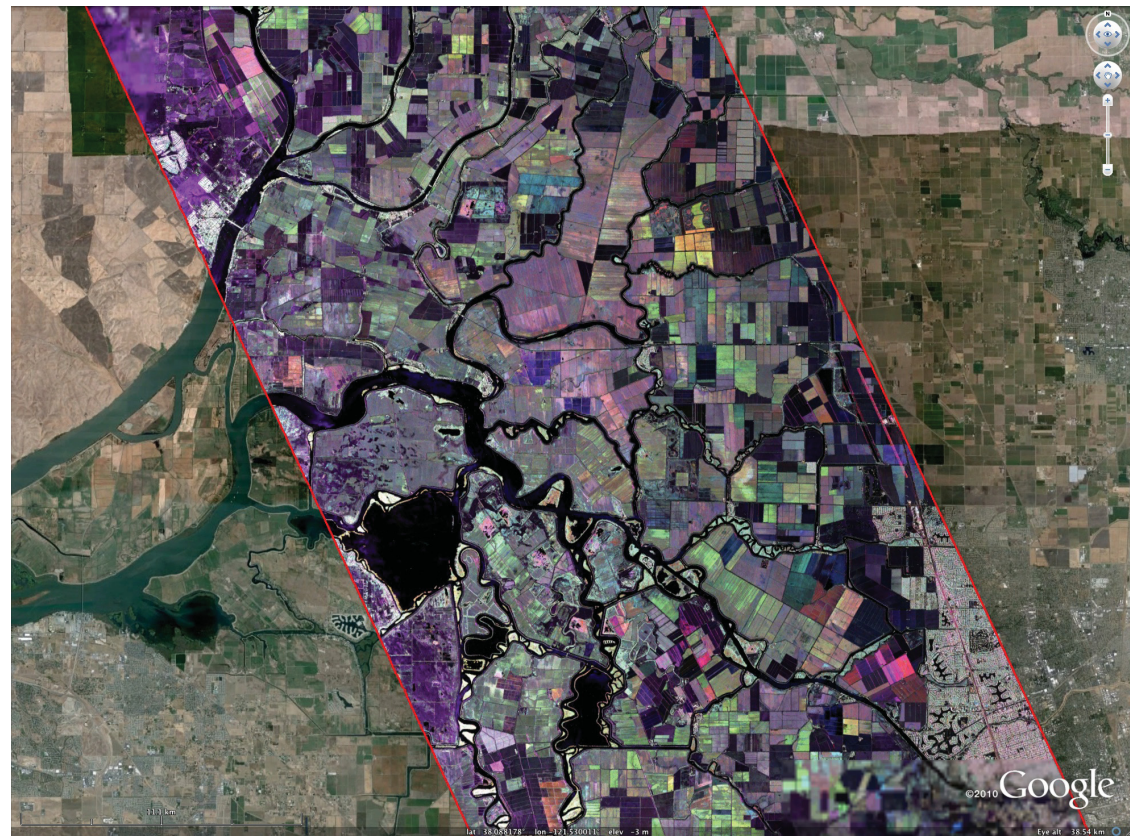


The UAVSAR L-band radar is housed in a pod flown on the NASA G-3 platform, shown here in flight over Edwards Air Force Base.



UAVSAR flights image the Delta ~ monthly from 3 different directions to detect changes in the levees and measure subsidence rates.

19 flights completed since July 2009

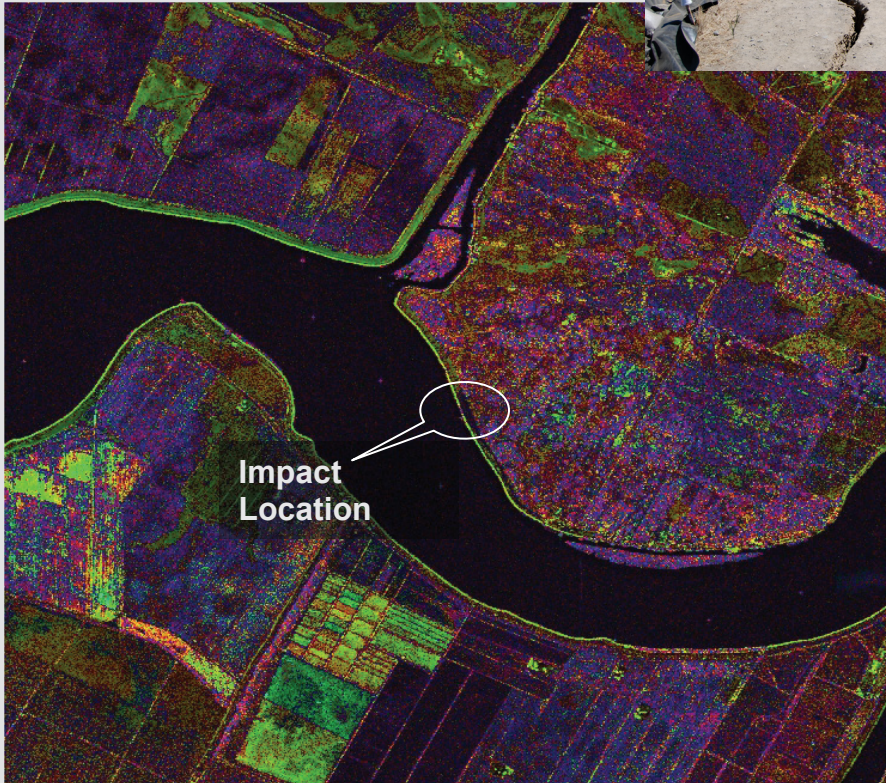


Radar Measurements of the Sacramento-San Joaquin Delta

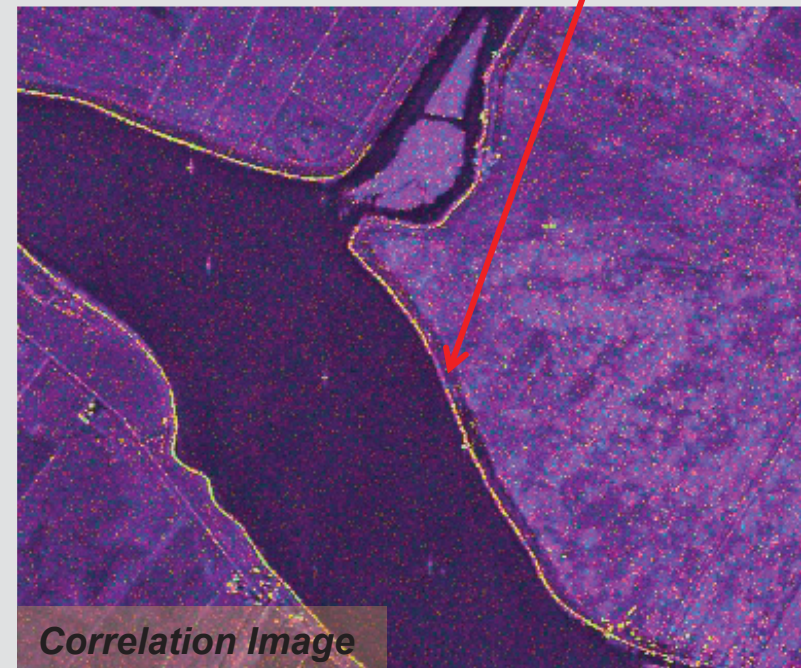
Damaged Levee Monitoring – The Initial Event and Long-term Effects

Bradford Island

Initial Effect:



A half-year after the event, the settling is spread out along more of the levee and smaller in magnitude.



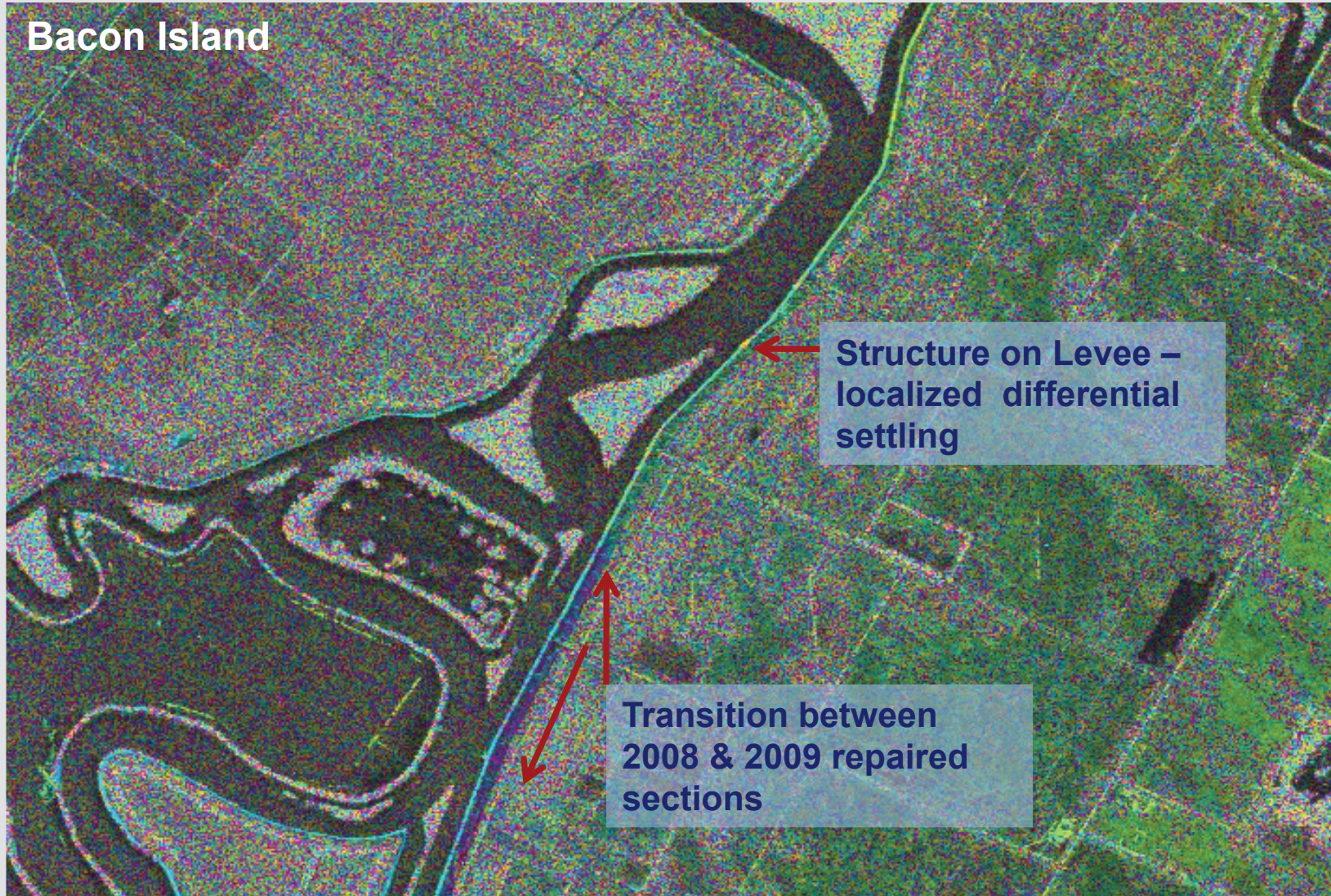
6 months temporal baseline 1/2010 - 7/2010

Radar Measurements of the Sacramento-San Joaquin Delta

Levee Change Detection

Bacon Island

1 year temporal baseline 7/2009 - 7/2010



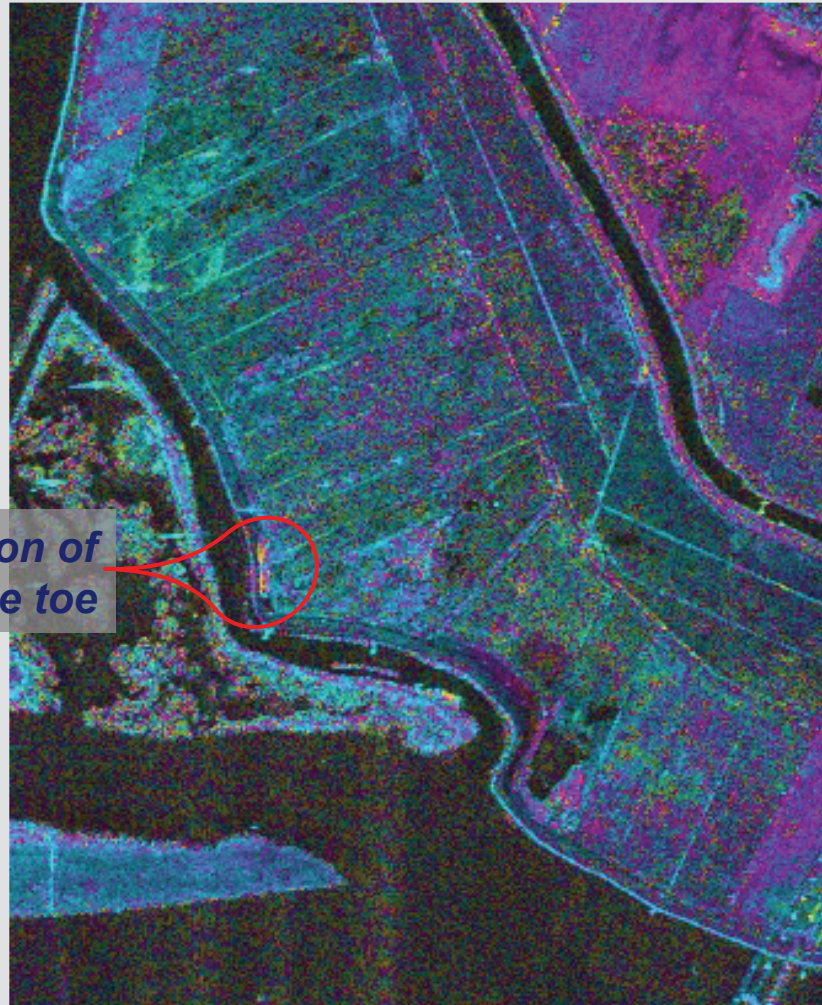
Radar Measurements of the Sacramento-San Joaquin Delta

New Levee Settling

Sherman Island Set-back Levee:

*Deformation of
levee toe*

*Settling and compaction of
new levees is normal. We
use this tool to isolate areas
with the most movement.*

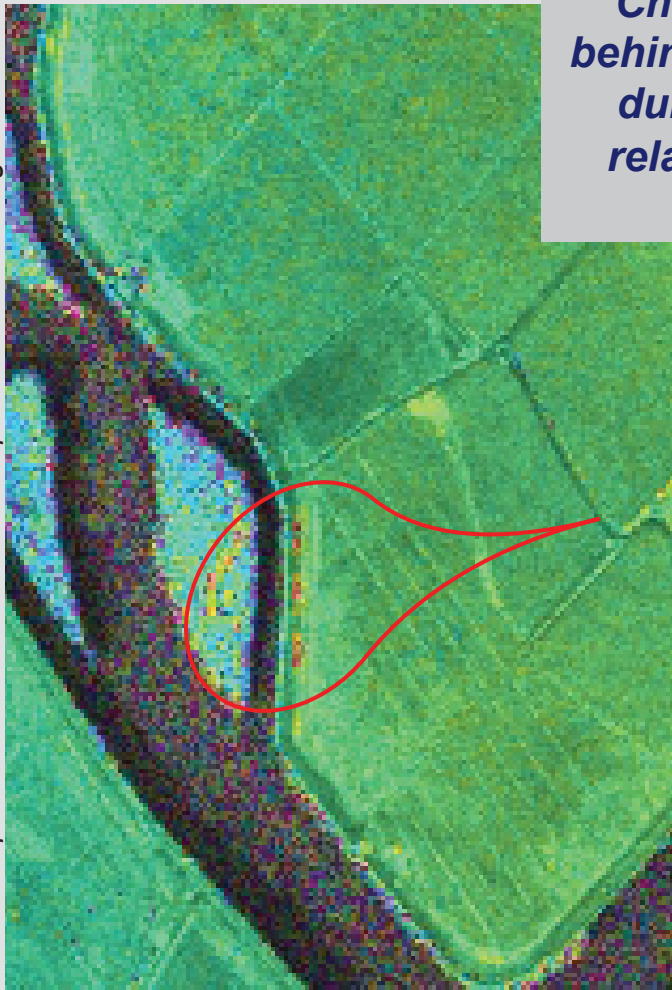


37 day temporal baseline 3/3/2010 – 4/9/2010

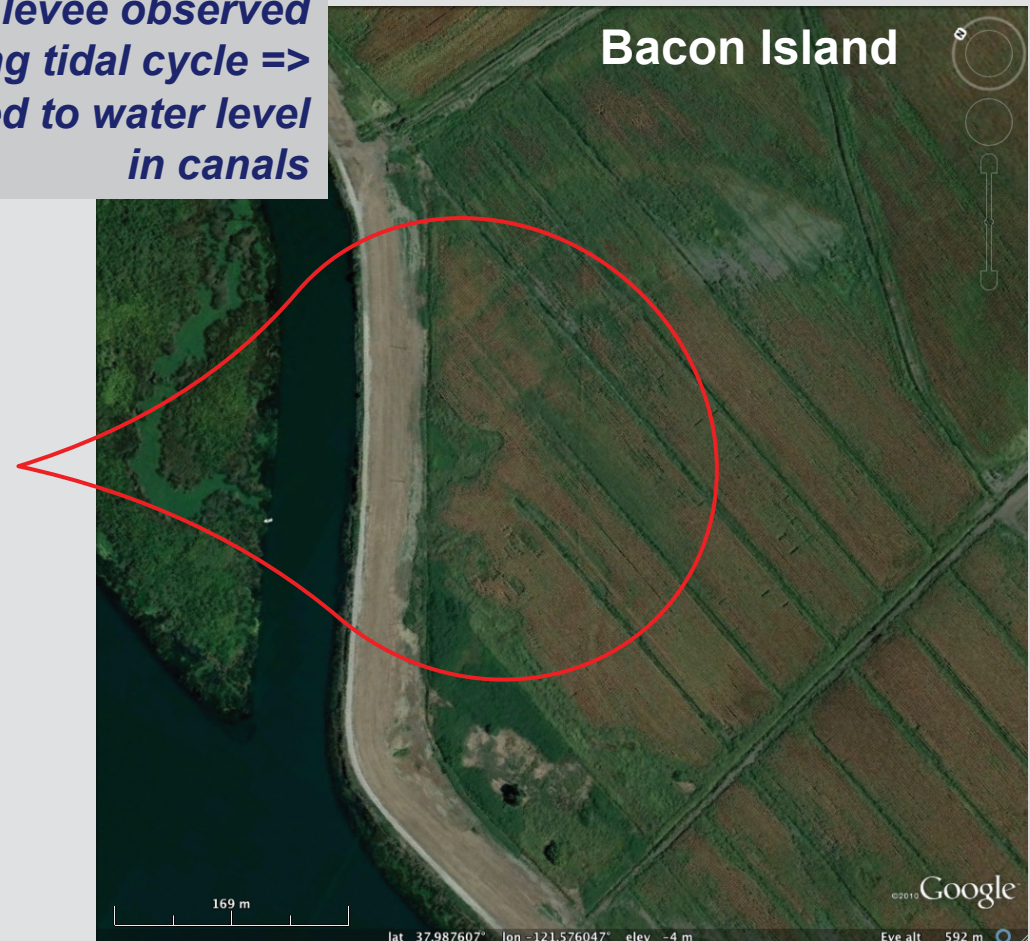
Radar Measurements of the Sacramento-San Joaquin Delta

Detecting Seepage Through Levees

3 hour temporal baseline 7/12/2010 HH-polarization interferogram



*Change immediately
behind levee observed
during tidal cycle =>
related to water level
in canals*

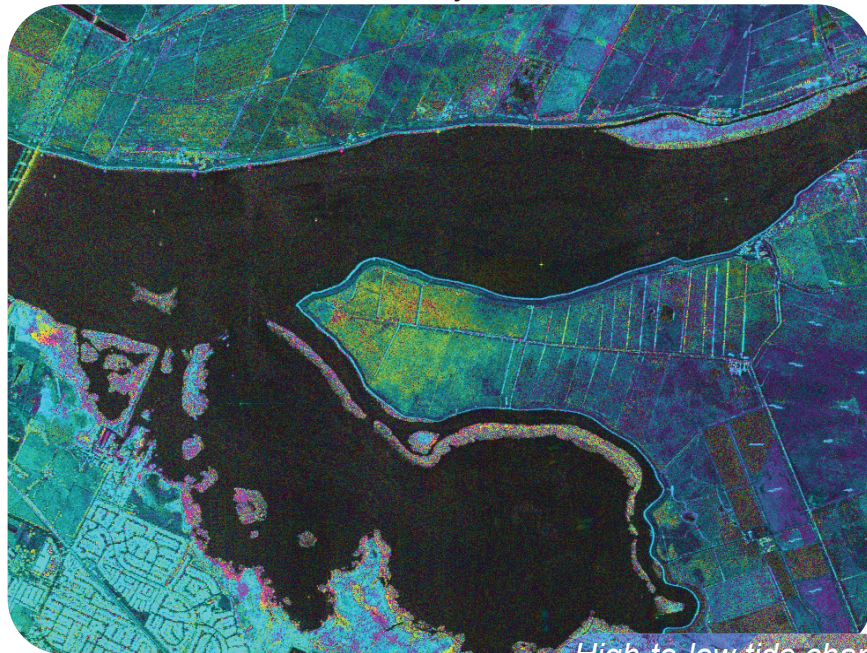


An objective of our study is to determine whether the change is induced by seepage through the levee or from man-made structures.

Changes in the Sacramento Delta and Suisun Marsh

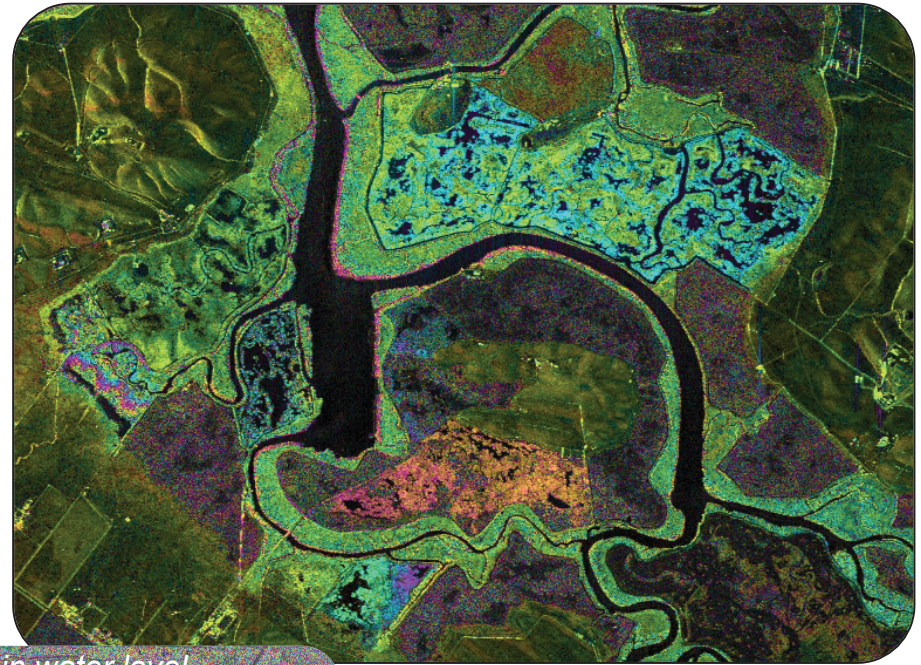
A few examples...

Blind Point Peninsula, Jersey Island

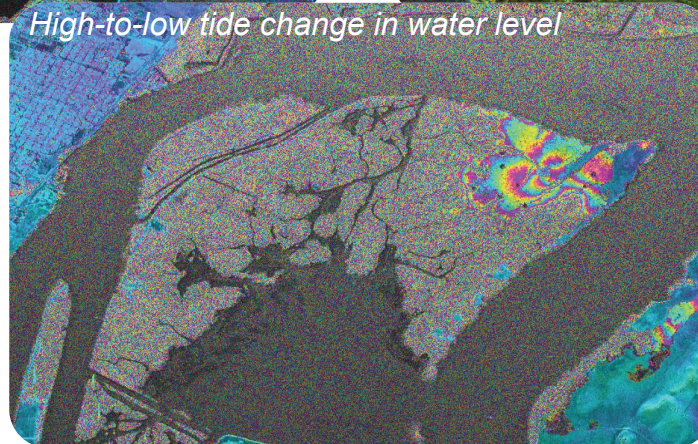


UAVAR pixel resolution = 7 m x 7 m

Suisun Marsh: vegetation, soil moisture, and water levels



High-to-low tide change in water level



Soil Moisture Change Detection

Changes in the radar return correlate with field boundaries, showing soil moisture changes.



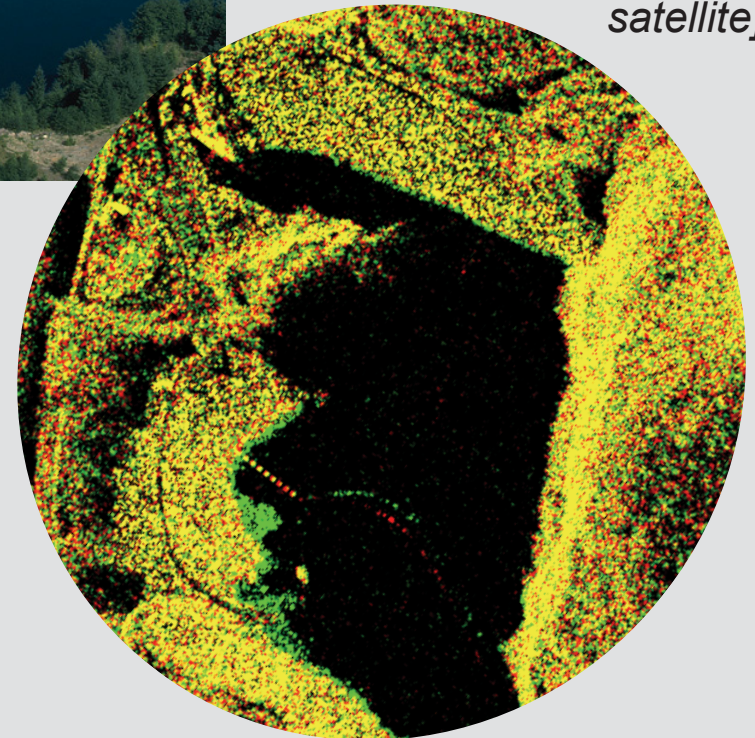
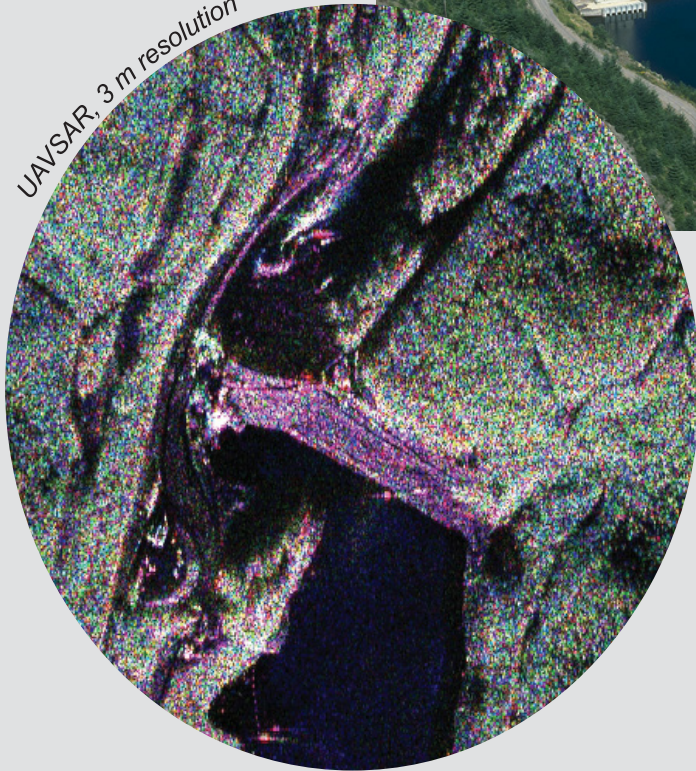
Dam Safety Program / Flooding

Monitoring Dam Embankments and Pools



*Green areas show
reservoir pool
lowering over 22
days in November
2010. [TerraSAR-X
satellite]*

UAVSAR, 3 m resolution

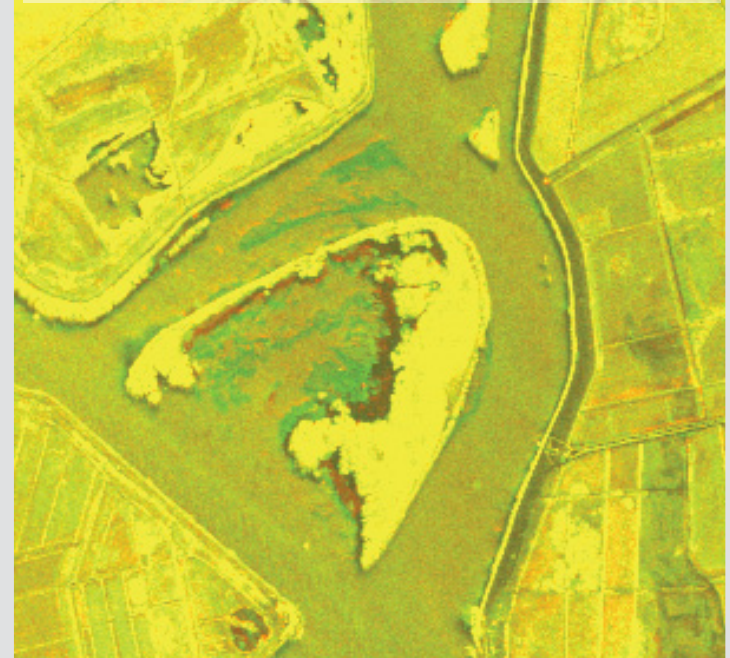


Dam Safety / Flooding

Sediment Deposition and Erosion

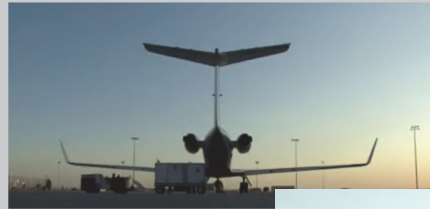


*Green areas in the water channel
show where erosion occurred
between July 2009 and July 2010]*

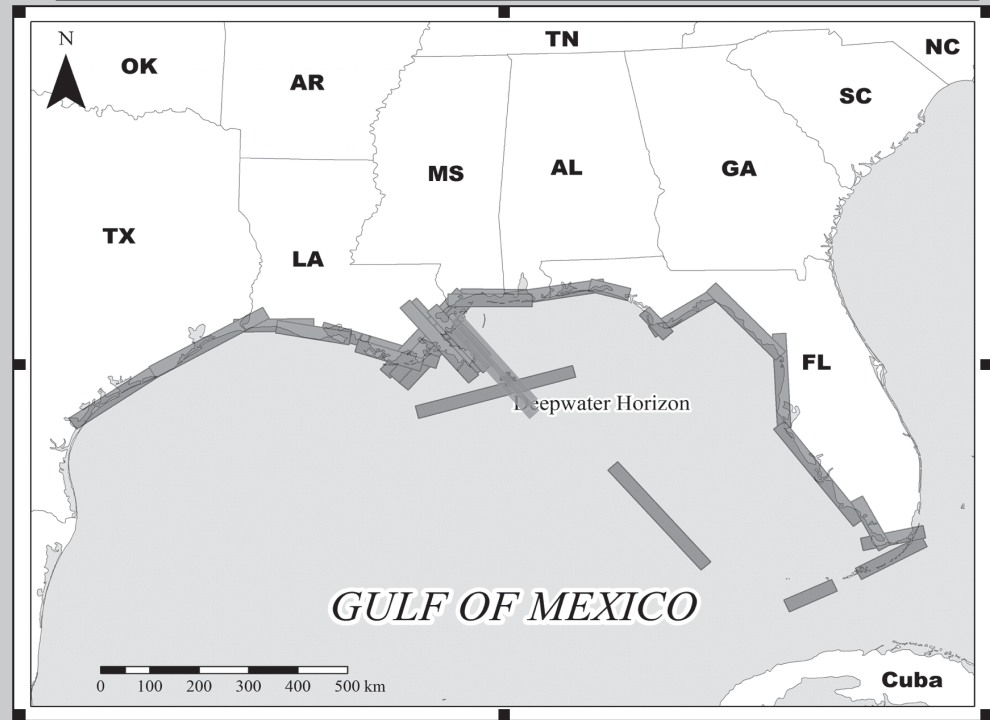


UAVSAR GULF OIL SPILL CAMPAIGN

22-23 JUNE 2010 DEPLOYMENT

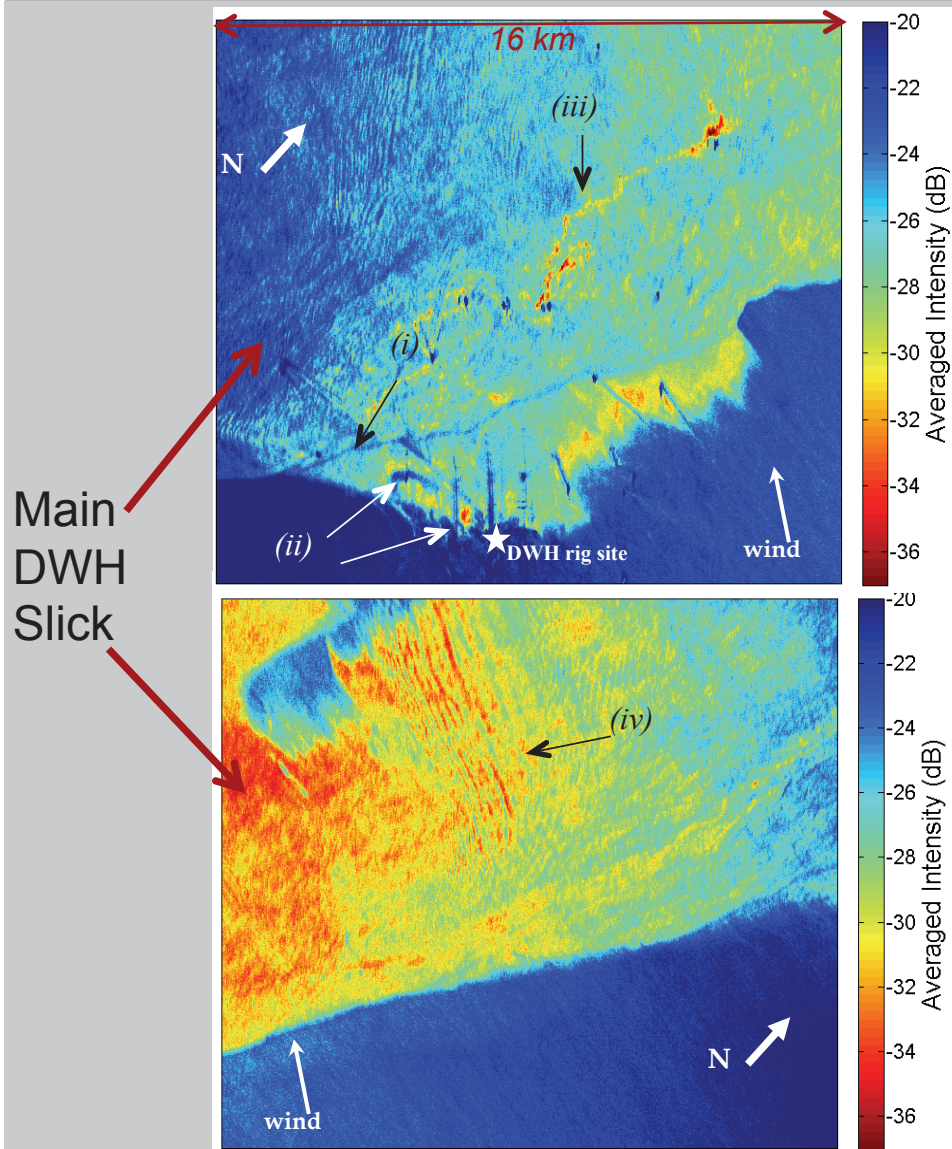


- 2 days, 20 flight hours
- ~5500 km of flight lines with 22 km swath width
- imaged an area of 120,000 km²

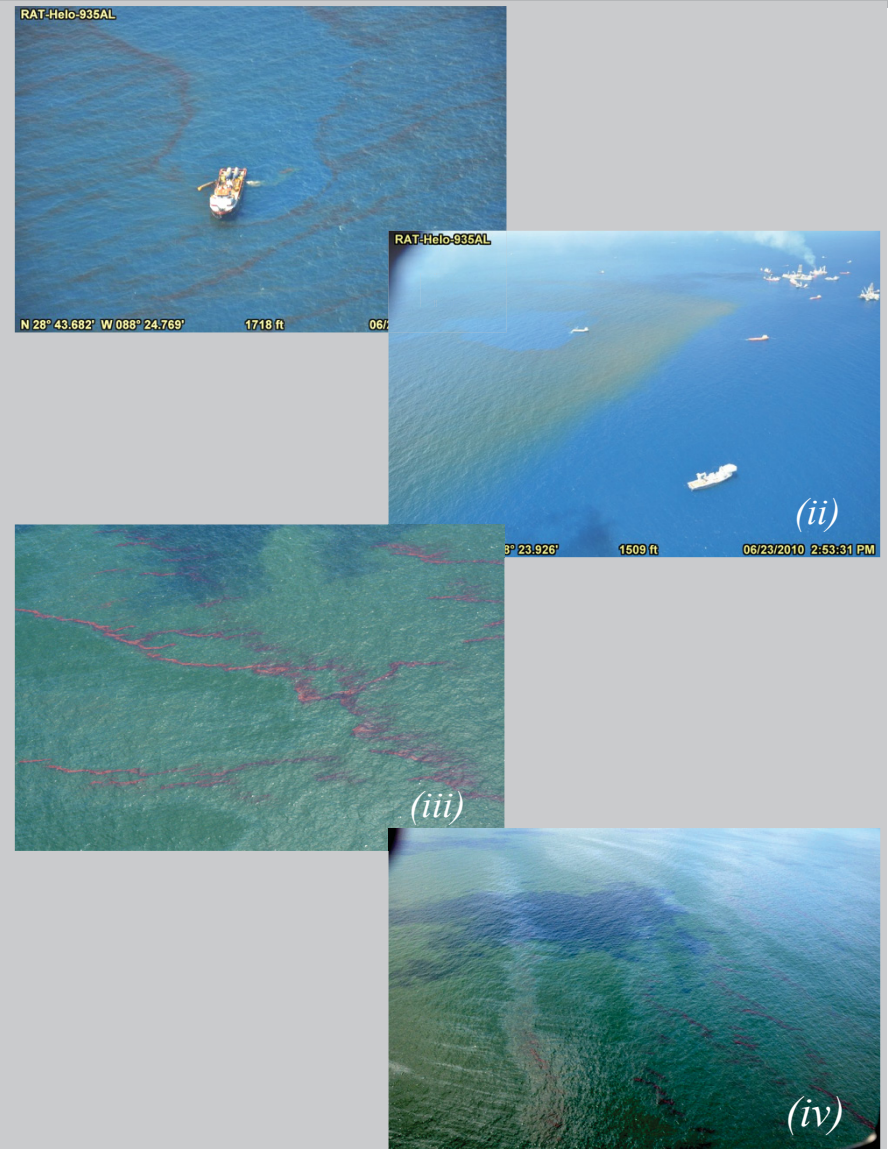


UAVSAR GULF OIL SPILL CAMPAIGN

OIL SLICK DETECTION AND CHARACTERIZATION



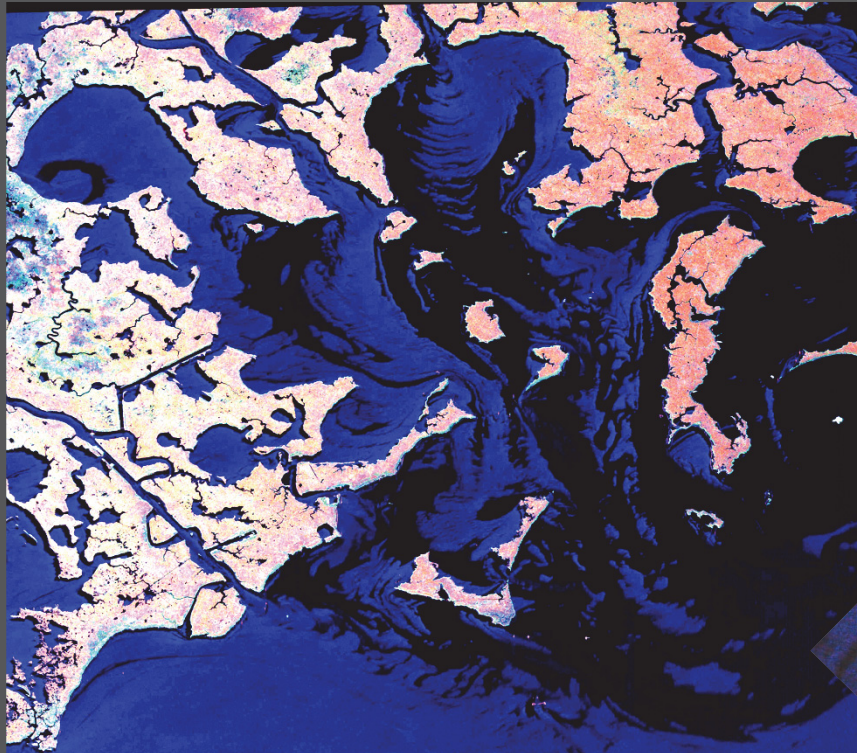
Main
DWH
Slick



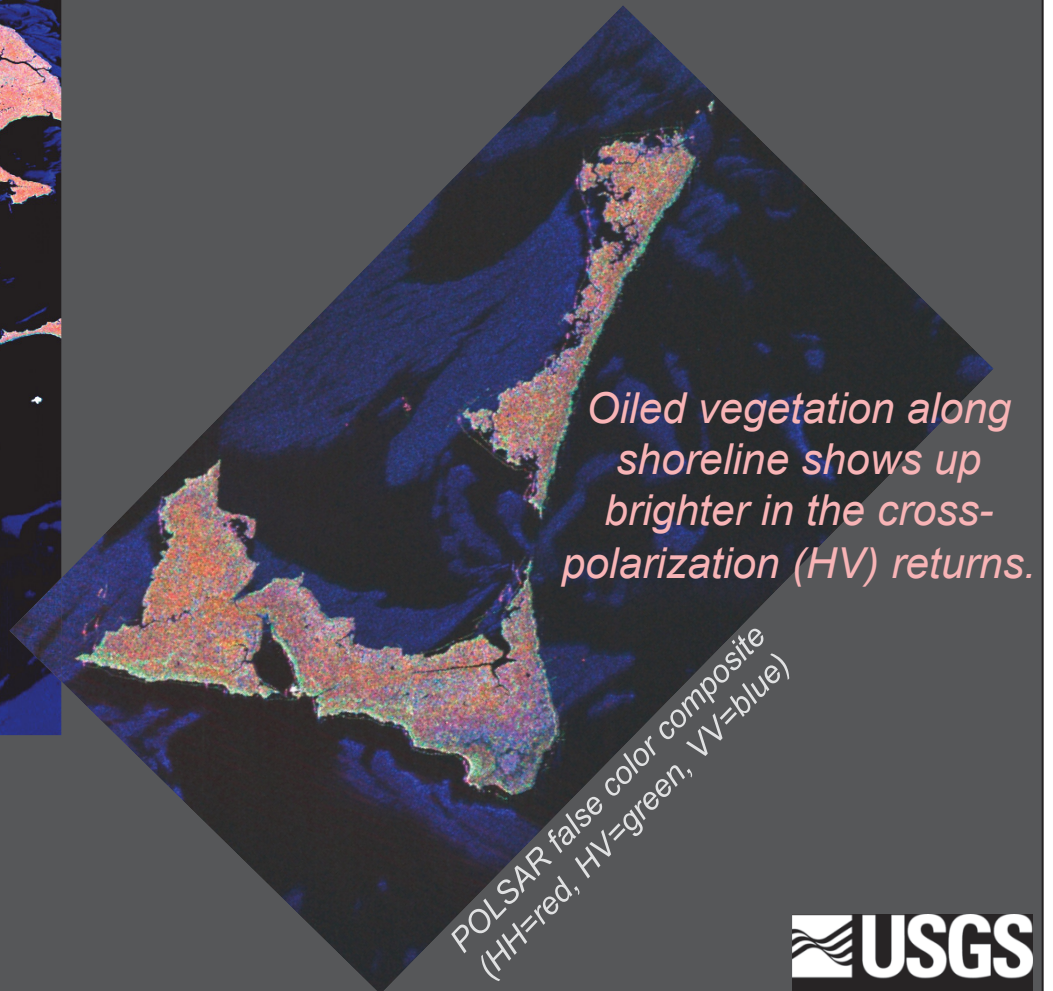
UAVSAR GULF OIL SPILL CAMPAIGN

MAPPING OIL EXTENT IN COASTAL WETLANDS

Barataria Bay, Louisiana:



Oil on water shows as dark areas in the radar image.



Oiled vegetation along shoreline shows up brighter in the cross-polarization (HV) returns.

*POLSAR false color composite
(HH=red, HV=green, VV=blue)*

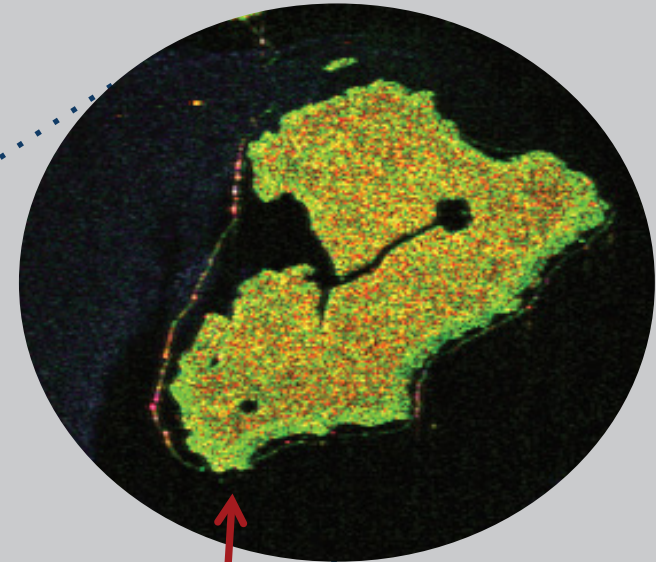
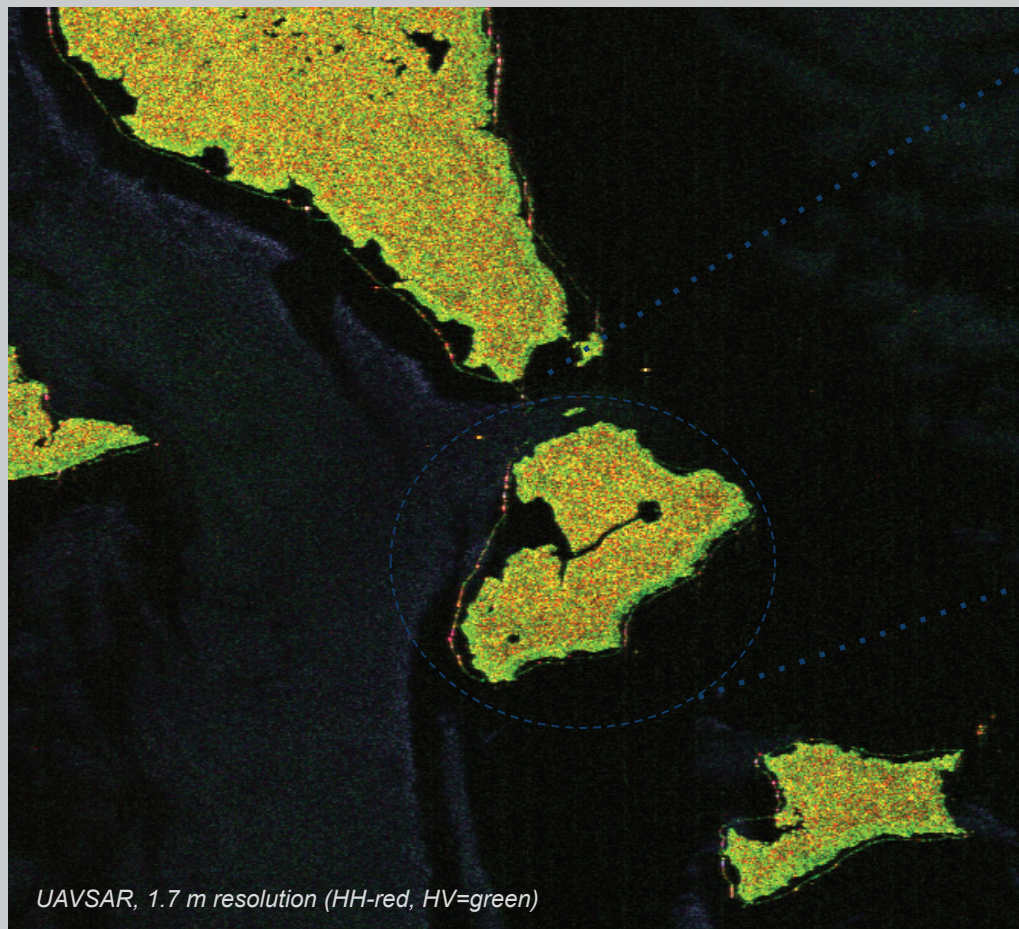


UAVSAR GULF OIL SPILL CAMPAIGN

RAPID RESPONSE APPLICATION: CONTAINMENT BOOMS

High Resolution Radar for Response and Recovery: Monitoring Containment Booms in Barataria Bay

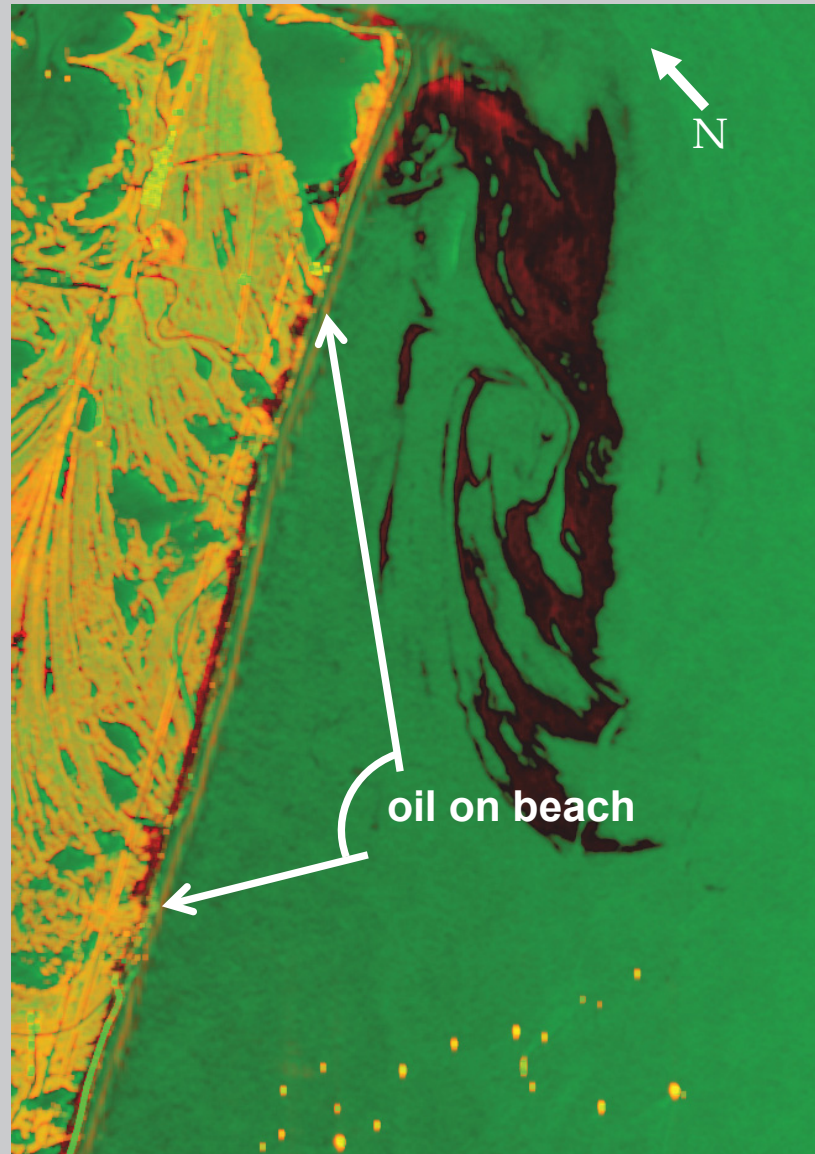
Cathleen Jones (*JPL/Caltech*), Bruce Davis (*DHS*)



UAVSAR GULF OIL SPILL CAMPAIGN

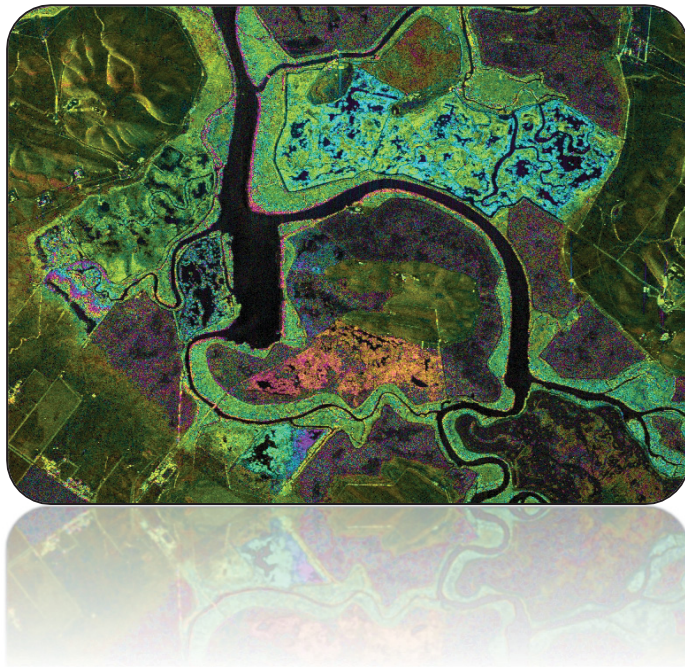
RAPID RESPONSE APPLICATION: OIL ON BEACHES

Elmer's Island, Louisiana
June 23, 2010



SAR Capabilities for Water Resource and Hazards Monitoring

Conclusions



Radar remote sensing offers great potential for high resolution monitoring of ground surface changes and water extent over large areas at one time.

Our pilot projects working with Ca. DWR to monitor levees in the Sacramento-San Joaquin Delta, observing dams for DHS, and monitoring the effects of the Deepwater Horizon oil spill are developing the knowledge base needed to monitor small-scale critical infrastructure and waterways for flood management and disaster response.